

# **CRN - DoE MICROTURBINE DEMONSTRATION PROGRAM**

**Cooperative Research Network  
of the National Rural Electric Cooperative Association**

Distributed Energy Resource Meeting  
College Park, MD      January, 2002  
Ed Torrero, CRN      Arlington, VA

# Rural Co-operatives . . .



- 1000 co-ops in 46 states
- 10% of power supply, 30 GW
- 45% of distribution lines, 75% of land mass
- 13+ million service connections, 34 million customers
- 60% residential, 35% commercial/industrial load

# DoE Microturbine Demo Program Objectives . . .

- **Collect test and operation information on installation and performance by NRECA participants**
- **Identify developmental needs re: permitting, interconnection and building code compliance**
- **Identify developmental needs re: technology, maintenance and operation**
- **Provide technology baseline to benchmark future improvements**

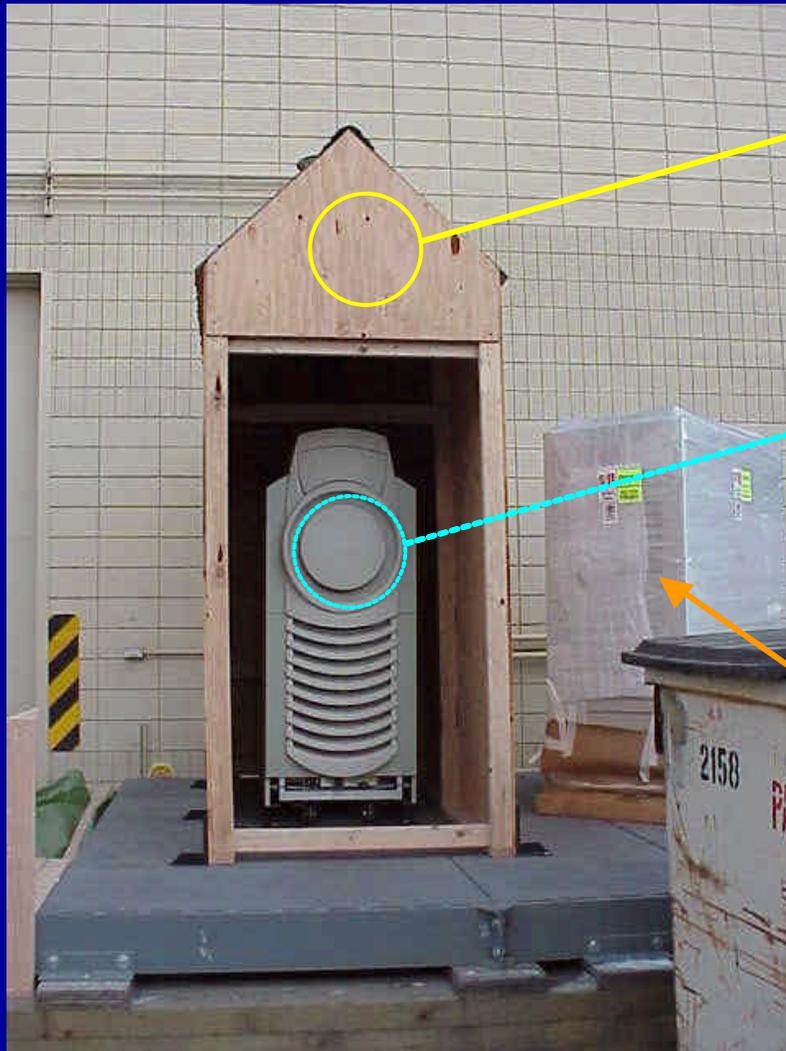
# Co-op Participants . . .



# Program Characteristics . . .

- **Multiple units at diverse sites operated by “real” co-op users**
- **Significant leveraging of funds**
  - EPRI / CRN
  - CRN
  - CO-OPS
  - DoE
- **Key CRN crosscheck access to parallel EPRI MT demonstration program**

# Gas Fired Capstone at Chugach Site . . .



- **Wooden enclosure halved troublesome tone noise to nearby residences**

- **Capstone now has a silencer retrofit kit for inside the micro-turbine cabinet**

- **Oil fired Capstone awaiting installation**

Photo courtesy of Chugach Electric Association  
Anchorage, AK

# Typical Co-op Reporting (Chugach) . . .



**Microturbine Demonstration Program:  
Installation Letter Report**

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Your Company Name? Chugach Electric Association  
 Contact person for this report? Peter Poray, PO Box 196300, Anchorage AK 99519,  
 ph 907-762-4788, fax 907-762-4816

Name and address of selected site? AVEC, 4831 Eagle St. Anchorage, AK 99503  
 Type of business at selected site? office & warehouse,  
 Microturbine and features to be demonstrated at this host site? Capstone, oil fired, no  
 cogen, grid parallel and grid independent

**Turbogenerator physical installation at site?**  
 Capstone unit on steel pad, electrical connection to main electrical panel inside building,  
 space on pad for an oil fired Capstone unit.  
 Pictures provided in earlier reports.

Altitude (feet)? 70

**Electrical Interconnect**  
 - Voltage? 208 V 3 phase  
 - Site kW and kVhD loads? 80 to 100 kW; 20,400 to 35,000 kWh per month.  
 - Present power and load factors? PF 95%; LF 35 to 48%  
 - No anti export, Chugach revenue meter records both in and out power flow  
 - Grid Independent planned for testing, not wired for powering panels in GI testing and will  
 run a load bank or resistance heaters.  
 \* Type of loads? Typical office and warehouse loads, some small shop welding and air  
 compressor equipment in warehouse  
 \* Did customer load have to be segregated to match turbine capacity? No, will run load  
 bank in GI mode.  
 \* What kind of grid isolation device was used? 100A-480v-4SN-SW fused disconnect  
 SquareD.

**Fuel: Oil**  
 - #1 diesel fuel  
 - Density or specific gravity? .81  
 - Heating value Btu/gal. 132,000  
 - Sulfur % wgt .3 max  
 - Cost per million Btu? \$10  
 - Is supply firm or interruptable? Firm

**Thermal Recovery (if any) N/A**

## • Interconnect

- 130 feet; 480 to 208 3-Ph via transformer
- 170 feet to new 15 psig NG, New oil tank

## • Costs: Demo and Com'l

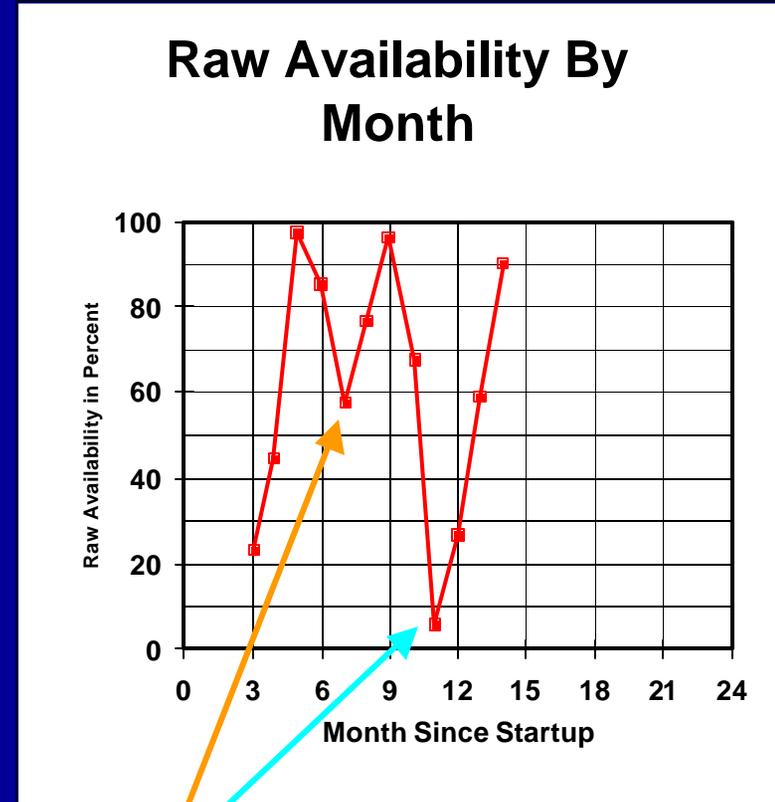
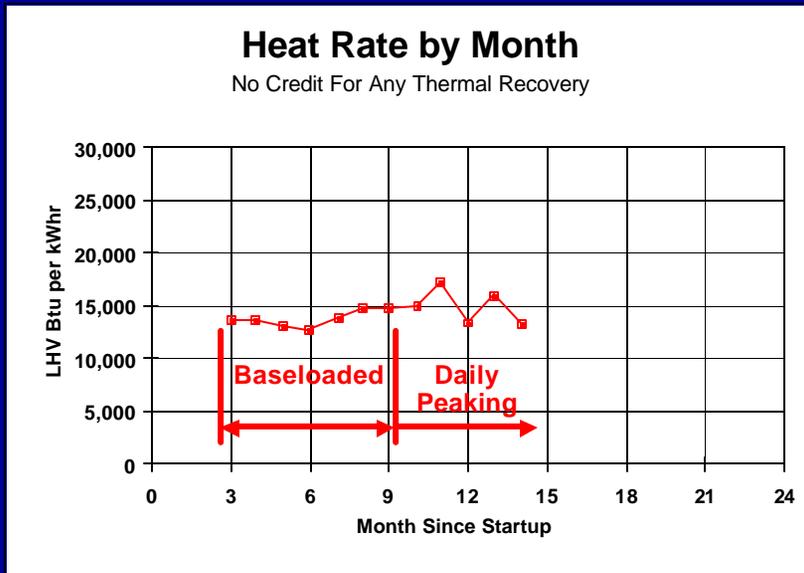
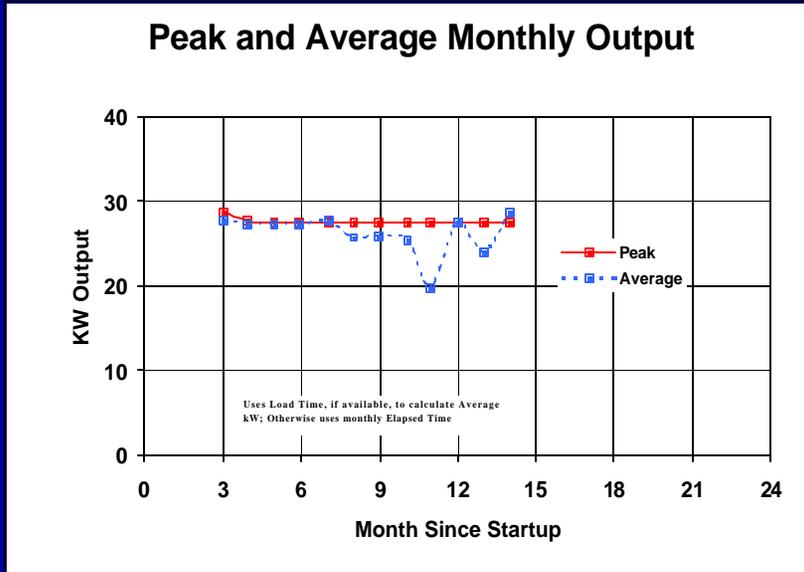
	Natural Gas	Fuel Oil
<b>Actual Demonstration:</b>		
Engineering	\$4,670	\$10,200
Permitting	3,300	560
Fuel	2,950	11,230
Electrical	9,500	9,500
Thermal Recovery	NA	NA
<b>Total</b>	<b>\$20,420</b>	<b>\$31,490</b>

**Projected if Full Commercial unit at customer site:**

**\$8,250      \$18,120**

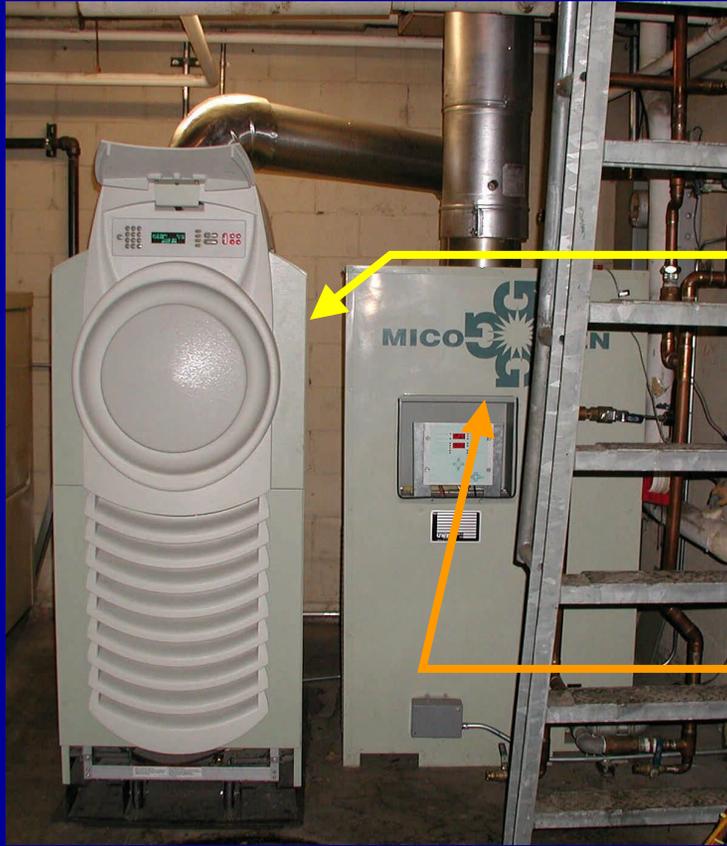
Site Installation Letter Report  
and Cost Spreadsheets

# Typical Co-op Reporting (Chugach) . . .



Reduced availabilities due to replacements of Rotary Fuel Compressor, etc. New air bearing design should enhance availability.

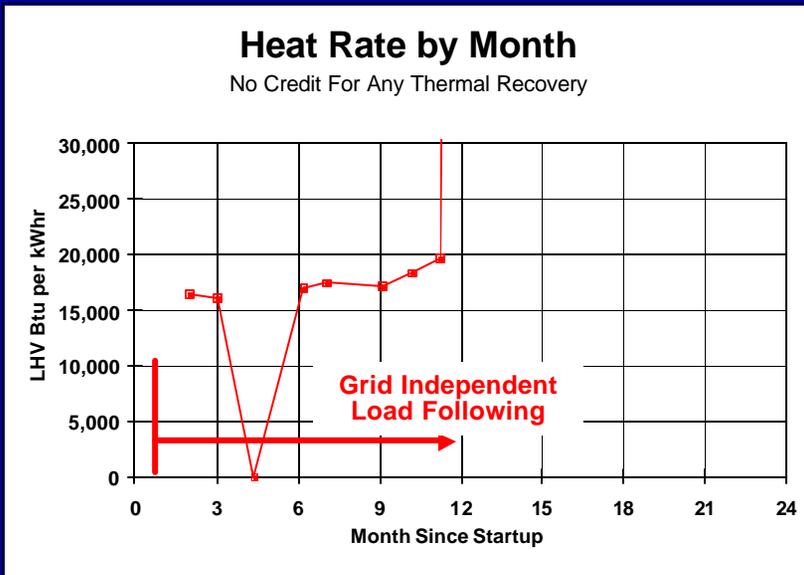
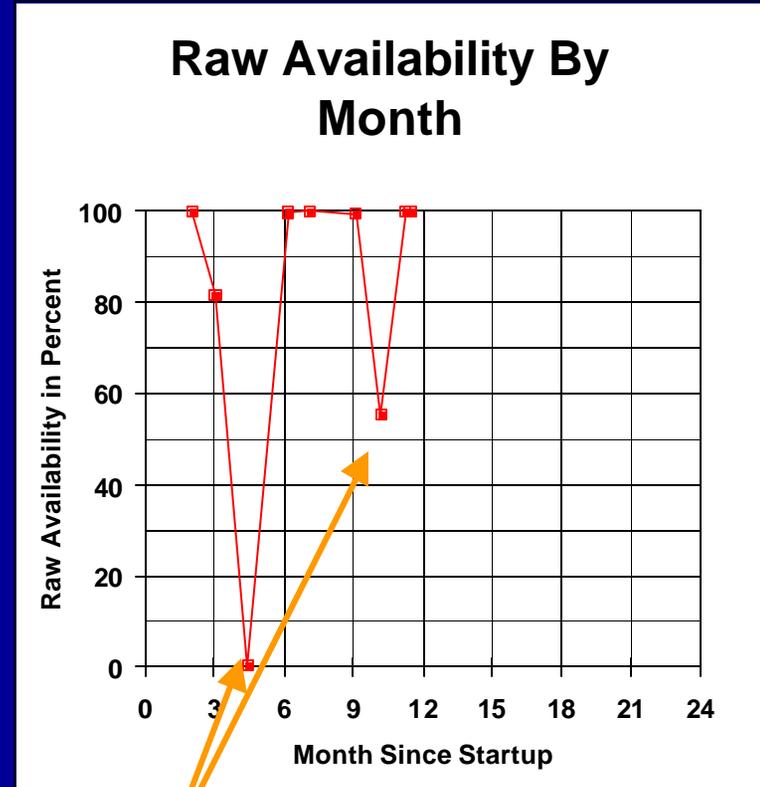
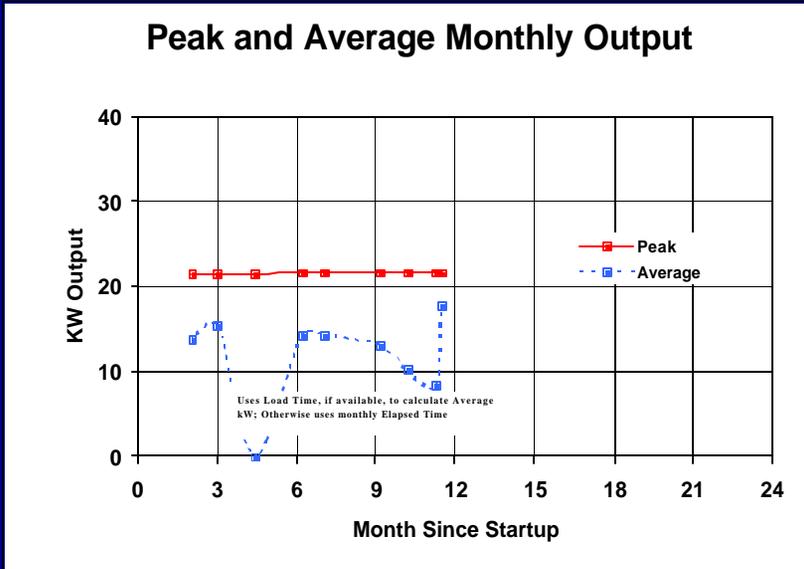
# Gas Fired Capstone at Cass County Site . .



CRN Demo Unit installed at Cass County

- Located at Holiday Inn in North Dakota
- Natural Gas at 11 psig - Runs Grid Independent
- Electric output powers an electric water heater!
- Thermal recovery is for additional water heating

# Typical Co-op Reporting (Cass County) . . .

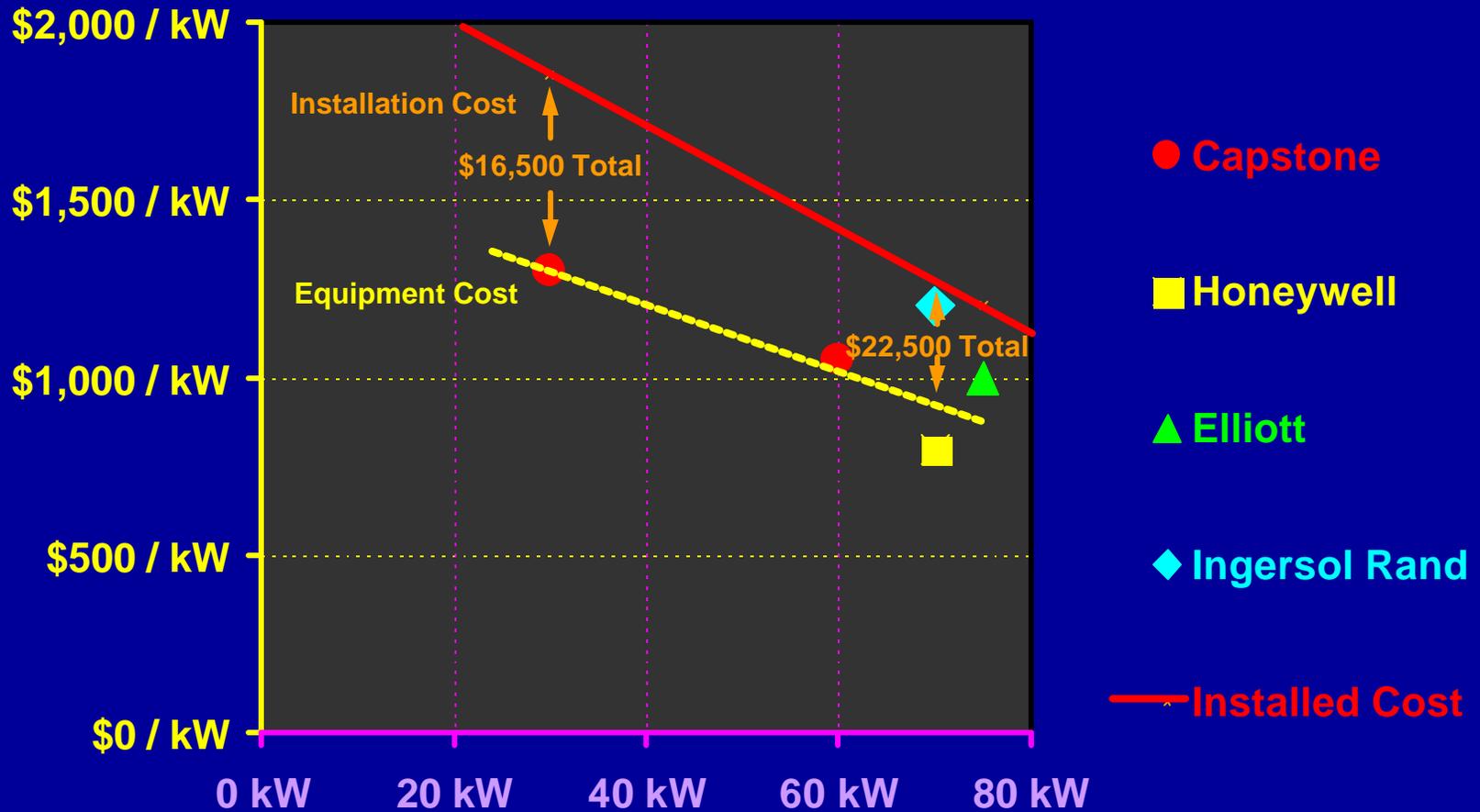


Reduced availabilities due to replacements of Rotary Fuel Compressor, etc.

# Technology Bottom Line . . .

- **No endemic technology failures to date (microturbine power assembly, recuperator, etc).**
- **Efficiencies about as represented.**
- **Capstone perhaps most “commercial” but all manufacturers beset by peripheral issues.**
- **Areas where design enhancements needed:**
  - Fuel gas compressor likely to remain a high-maintenance item and energy consumer (~5 to 7% of kWh)
  - Limited motor start capability constrains Grid Independent use
  - Inverters may need more “hardening” relative to grid

# Typical Equipment and Installation Costs . . .



**Doubling the Size: Reduces Equipment Cost per kW by 20%**  
**Reduces Installation Cost Component per kW by 35%**

# How Does Cost Stackup?

## Cost to Customer (Cents / kWh)

	Rural Co-op	IOU Electric	Customer Owned
<b>Peaking @ 1,500 Hours per year</b>			
Owning Cost	14.3	20.3	24.6 to 34.2
\$6 /MilBtu NatGas* + 1.5¢ Maint	8.6	8.6	8.6
<b>Total</b>	<b>22.9</b>	<b>28.9</b>	<b>33.2 to 42.8</b>
<b>BaseLoad @ 95% avail = 8,322 Hours per year</b>			
Owning Cost	2.6	3.7	4.4 to 6.2
\$6 /MilBtu NatGas* + 1.5¢ Maint	8.6	8.6	8.6
<b>Total</b>	<b>11.2</b>	<b>12.3</b>	<b>13.0 to 14.8</b>

\* \$1.20 / gallon Fuel Oil is equivalent to \$8.65 per million Btu Natural Gas ...and... \$1.10 per gallon Propane is equivalent to \$12 per million Btu Natural Gas

**Basis:** Excludes cogeneration credit which at full thermal recovery could reduce busbar costs 2.5 ¢/kWh for gas price of \$6.00 per MilBtu.

\$1,100 / kW equipment plus \$275 / kW installation      10-Year equipment life

14,200 HHV Btu / kWh heat rate      Maintenance at 1.5 cents per kWhr

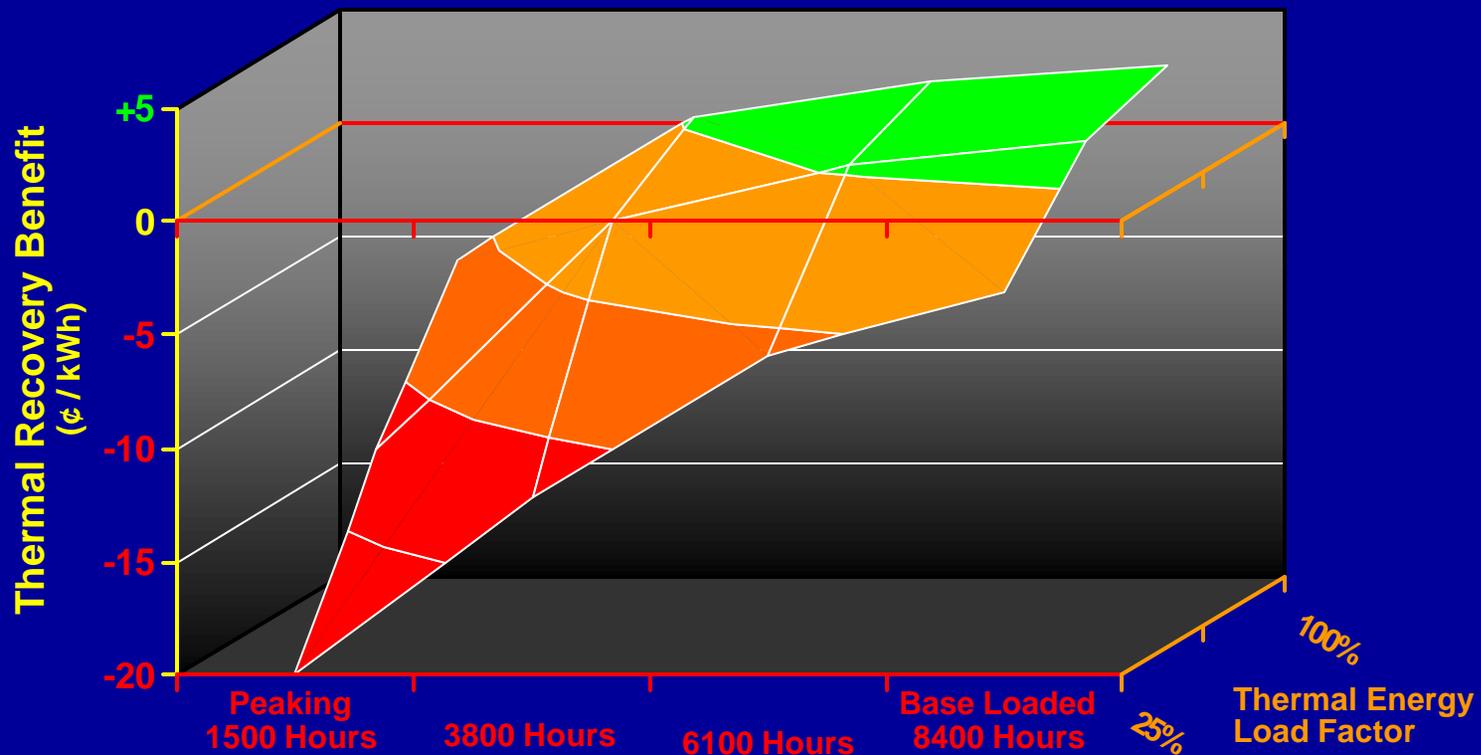
Debt is at 9% were applicable      Utility ROE is 18%

Customer Owned ROE is 25% → 3.3 Yr Payback      Range is w w/o debt financing

7-Year MACRS for FIT where applicable      No Investment Tax Credit

Combined FIT + State Income Tax rate is 41.5%

# Thermal Recovery Attractiveness?



- Unless electric thermal displaced, cost effective thermal recovery requires base loaded operation and maximum thermal use. → **Applicable sites limited!**
- Thermal recovery Installation Cost can quickly spiral if every last Btu chased.

*Basis: \$25,000 cost to install 330,000 Btu/Hour Thermal Recovery at a 60 kW microturbine site  
Customer owns thermal recovery equipment and requires a 3.3 year payback  
Displaced thermal use was fueled by \$6 natural gas at a 75 percent combustion efficiency*

**Thank You**

**Questions????**